TESTIMONY ON PEAK OIL

By

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Summary:

- Peak Oil will come, as oil is a limited resource. As we use 30 billion barrels per year and new discoveries are much less than this, we are now consuming from our reserves. Depending on demand Peak Oil will happen within the near future. Currently year 2010 is the most likely year for Peak Oil.
- Studies of the correlation between oil consumption and the growth of GDP in individual countries as well as for the world shows that since 1900 there not has been an increase in GDP without an increase in the use of oil.
- USA with 5 percent of the world's population should not in future continue to consume 25 percent of the global oil production if it means depriving other nations of essential fuels.
- Even a crash program for production of oil from Canadian oil sands will yield only a limited amount of oil.

Mr. Chairman, ladies and gentlemen on the committee:

I thank the Committee for this opportunity to discuss Peak Oil and the work of Uppsala Hydrocarbon Depletion Study Group, Uppsala University, Sweden. We are also members in the network of ASPO, the Association for the Study of Peak Oil and Gas, and I'm since 2003 president of ASPO. Members of ASPO, including the ASPO-USA affiliata, have an interest in determining the date and impact of the peak and decline of the world's production of oil and gas, due to resource constraints (www.peakoil.net).

The mission is to:

1. Define and evaluate the world's endowment of oil and gas.
2. Model depletion, taking due account of demand, economics, technology and politics.
3. Raise awareness of the serious consequences for Mankind.

I like to summarize the global situation for Peak Oil the following way: When I was born in 1945, none of the four small farms in my little Swedish village used oil for anything. Ten years later, the oil age had arrived: we had replaced coal with oil for heating, my father had bought a motorcycle, and tractors were seen in the fields. From 1945 to 1970, Sweden increased its use of energy by a factor of five, or nearly 7 percent per year for 25 years. This journey into the oil age transformed Sweden from a rather poor country into the third wealthiest country (per capita) in the world. Ninety percent of the energy increase came from oil. Cheap oil made Sweden rich.

Now consider China, a developing country with 21 percent of the global population. It consumes 8 percent of the global oil supply, and thinks it is fair to claim 21 percent of daily global consumption, or 17.6 million barrels per day (mbpd). During the last five years the

average annual GDP growth in China has been 8.2 percent and the average increase in oil consumption 8.4 percent per year. We can now see the same correlation between increase in GDP and use of oil in China as in Sweden 50 years ago. If China's economy grows 8 percent per year over the coming five years, we can expect that it will need an increase in the consumption of oil of 3 million barrels per day by 2010. According to Professor Pang Xiongqi at the China University of Petroleum in Beijing, China's production will plateau in 2009 and then start to decline. This means that the total increase in consumption must be imported. As China is already importing 3 million barrels per day, it will have to increase imports 100 percent during the next five years. Where will it come from?

Since 2001, when ASPO was founded, we have tried to tell the world that there will soon be a problem supplying the world with crude oil while demand continues to rise. The estimated peak-production year at the first depletion workshop in Uppsala in 2002 was 2010. Two years later at our Berlin meeting it had moved to 2008, and now it looks like we are back to 2010, because production from deepwater oil fields will yield more than we expected. The exact year for peak oil depends very much on future demand and we will not know when we have peaked until we have crossed the threshold. It will certainly happen before 2020.

Unfortunately, few have heeded our alerts, even though the signs have been so obvious that a blind hen could see them. Fifty years ago the world was consuming 4 billion barrels of oil per year and the average discovery rate (the rate of finding undiscovered oil fields) was around 30 billion barrels per year. Today we consume 30 billion barrels per year and the discovery rate is dropping toward 4 billion barrels per year (see figure 1). This is significant; Chevron is even running an ad saying, "The world consumes two barrels of oil for every barrel discovered." (By discovery, I mean only new oil fields. Some analysts include reserve growth—newly accessible

oil in old fields—as new discoveries, but we are using the same approach as in World Energy Outlook 2004, IEA, International Energy Agency)

If we extrapolate the downward discovery slope from the last 30 years in figure 1, we can estimate that about 135 billion "new" barrels of oil will be found over the next 30 years. The latest large oil field system to be found was the North Sea (in 1969), which contains about 60 billion barrels. In 1999 the North Sea field production peaked at 6 mbpd. Our extrapolation suggests that over the next 30 years we will discover new oil fields equal to twice the size of the North Sea—a very pessimistic prediction, according to our opponents. But I think the oil industry would be ecstatic to find two new North-Sea-size oil provinces.

The World Energy Outlook 2005 base-case scenario projects that by 2030 global oil demand will be 115 million barrels per day, which will require increasing production by 31 million barrels per day over the next 25 years, of which 25 mbpd is predicted to come from fields that have yet to be discovered. That is, we'll have to find four petroleum systems of the size of the North Sea. Is this reality?

Every oilfield reaches a point of maximum production. When production falls advanced technologies can reduce but not eliminate the decline. The oil industry and the IEA accept the fact that the total production from existing oil fields is declining. ExxonMobil informed shareholders that the average production decline rate for the global oil fields are between 4 and 6 percent per year (The Lamp, 2003, Vol85, No1). Current global production is 84 million barrels per day, so next year at this time current fields may produce a total of roughly 80 million barrels per day. Given the expected increase in global GDP, one year from now total oil demand will be 85.5 mbpd—so new capacity might have to make up for 1.5 mbpd plus 4 mbpd, or 5.5 mbpd. Two years from now the needed new production will be 11 mbpd and in 2010 at least 25 mbpd.

Can the industry deliver this amount? If we extend the decline in existing fields through 2030, and accept the 2004 scenario by the Energy Information Administration (global demand of 122 mbpd), then "we need new production that is of the order of 10 new Saudi Arabias." Some might call this a doomsday scenario, but if so I'm not the doomsayer—it's Sadad Al Husseini, until recently vice-director of Saudi Aramco, the largest oil company in the world.

Excluding deepwater oilfields, output from 54 of the 65 largest oil-producing countries in the world is in decline. Indonesia, a member of the Organization of Petroleum Exporting Countries (OPEC), not only can't produce enough oil to meet its production quota, it can't even produce enough for domestic consumption. Indonesia is now an oil importing country. Within six years, five more countries will peak. Only a few countries—Saudi Arabia, Iraq, Kuwait, United Arab Emirates, Kazakhstan, and Bolivia—have the potential to produce more oil than before. By 2010, production from these countries and from deepwater fields will have to offset the decline in 59 countries and the increased demand from the rest of the world.

Can they do it? Let's look at Saudi Arabia, which in the early 1980s produced 9.6 million barrels per day. According to the IEA and the EIA Saudi Arabia must produce 22 mbpd by 2030. But Sadad Al Husseini claims that "the American government's forecasts for future oil supplies are a dangerous over-estimate." The Saudi Ghawar oil field, the largest in the world, may be in decline (see for example the book “Twilight in the dessert” by Mathew Simmons). Saudi Aramco says that production can be increased to 12.5 mbpd in 2015. They plan a new pipeline with a capacity of 2.5 mbpd, so it looks like they are willing to increase production to 12.5 mbpd, but so far there are no signs of reaching 22 mbpd.

Now consider Iraq, which in 1979 produced 3.4 mbpd. Iraq officially claims reserves of 112 billion barrels of crude oil, but ASPO (and other analysts) think that one-third of the

reported reserves are fictitious "political barrels." At a recent meeting in London, I was told (privately, by a person who is in a position to know) that Iraqi reserves available today for production total 46 billion barrels. If this is the case, it will be hard for Iraq to reach its former peak production level in a short time.

And so on. It's time to ask, can the Middle East ever again produce at the peak rates of the 1970s?

Many countries in the world are very poor. It may be necessary to double global GDP to achieve any kind of decent life for people in these countries. The examples of Sweden and China suggest that, if past economic development patterns are followed, doubling GDP will require doubling global oil production. Can this even be done?

The United States, the wealthiest country in the world, has 5 percent of the global population and uses 25 percent of the oil. It is time to discuss what the United States should do to cut consumption—and rapidly. In February 2005 a report for the U.S. Department of Energy, DoE, (Peaking of World Oil Production: Impacts, Mitigation, & Risk Management) argued that "world oil peaking represents a problem like none other. The political, economic, and social stakes are enormous. Prudent risk management demands urgent attention and early action." Any serious program launched today will take 20 years to complete.

What about oil sands? The enormous reserves of oil sands in Canada are often mentioned as a lifesaver for the world. The report to DoE in February inspired us to undertake a “Crash Program Scenario Study for the Canadian Oil Sand Industry” (B. Söderbergh, F. Robelius, and K. Aleklett, to be published). In the study we found that Canada must very soon decide if its natural gas should be exported to USA or instead used for the oil sands industry. In a short-term crash program the maximum production from oil sands will be 3.6 million barrels per day in

2018. This production cannot offset even the combined decline of just the Canadian and North Sea provinces (see Fig.2). A long-term crash program would give 6 million barrels by 2040, but then new nuclear power plants would be needed to generate steam for the in-situ production.

In view of the importance of the world's future energy supply, The Royal Swedish Academy of Sciences (the Academy that awards the Nobel Prizes in physics, chemistry, and The Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel) has recently established an Energy Committee. The Academy is an independent non-governmental organization, with expertise in most of the sciences as well as economic, social, and humanistic fields. The Energy Committee has selected a number of subjects to be studied in some depth and one of these deals with oil and related carbon-based fuels. The Academy organized hearings and a seminar before subsequently (on October 14, 2005) issuing a statement about oil (the full statement can be found at the end of this text). I'll note just one excerpt from the general remarks: "It is very likely that the world is now entering a challenging period for energy supply, due to the limited resources and production problems now facing conventional (easily accessible) oil."

From figure 1 we can conclude that the peak of global discovery of oil was around 1960. In figure 3 we have a well-defined discovery peak for US Lower 48. This peak defines how much can be produced and Peak Oil for the region was 35 years later in 1971. Based on the assumption that we only can consume the oil we have already found and expect to find, we have predicted oil production in the future for the world till 2050 (figure 4). Deep water is the latest oil-production frontier. During the coming years a number of large fields will come into production, and we believe that the peak production from these fields will define the upper time limit for peak oil. Based on the data available today, we can expect global Peak Oil in 2010, with a few years uncertainty.

Animals that face food shortages have a hard time adjusting and usually their populations decline. Some believe that we as human beings will face a similar situation. I can't accept that. As human beings we can think and come up with ideas, and I believe we can find solutions. The road will be bumpy and many people will be hurt, but when we arrive at the end of this road, it must be as a sustainable society. It will not be possible to travel this road without using part of the existing stocks of fossil fuels and, for industrial countries, nuclear energy as well, but we can do it in a manner that will have minimal impact on the planet. The problem is that we should have started at least 10 years ago. We must act now, as otherwise the bumps and holes in the road might be devastating.

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Figures:

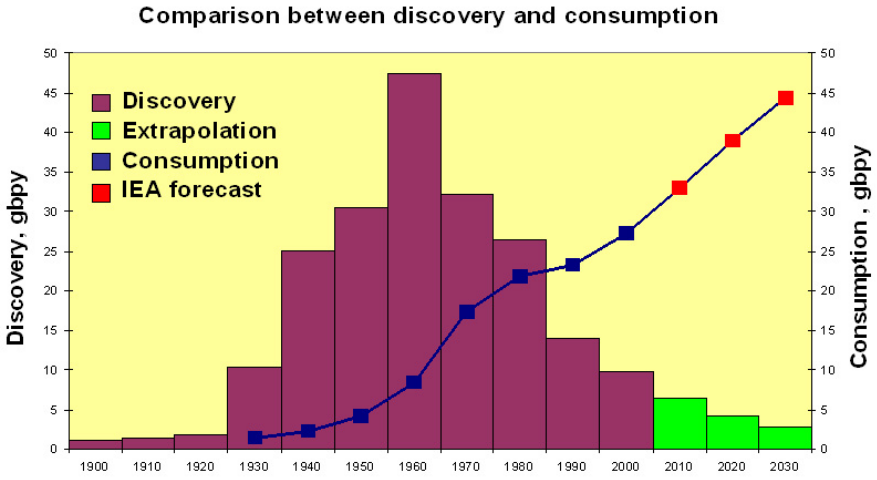

Figure 1: Discovery of conventional oil and extrapolation of future discoveries and consumption of conventional oil and predicted consumption according to IEA. The number for year 2000 is the average number for the years 1995 to 2004, etc. (K. Aleklett, www.peakoil.net)

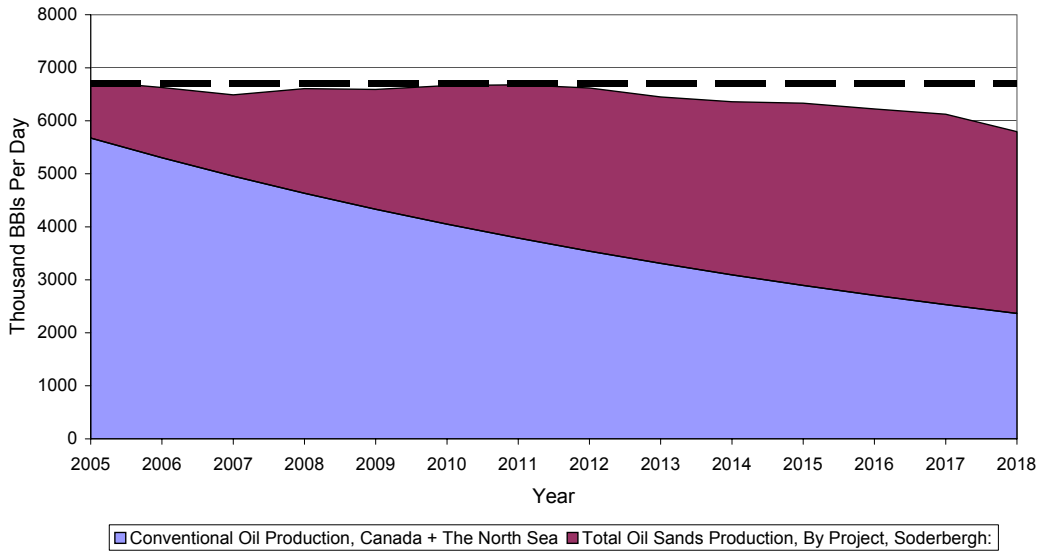

Fig 2. Canadian Conventional + The North Sea + Canadian Oil Sands Crash Program Crude Oil Production 2005 – 2018 (B. Söderbergh, F. Robelius, and K. Aleklett, to be published)

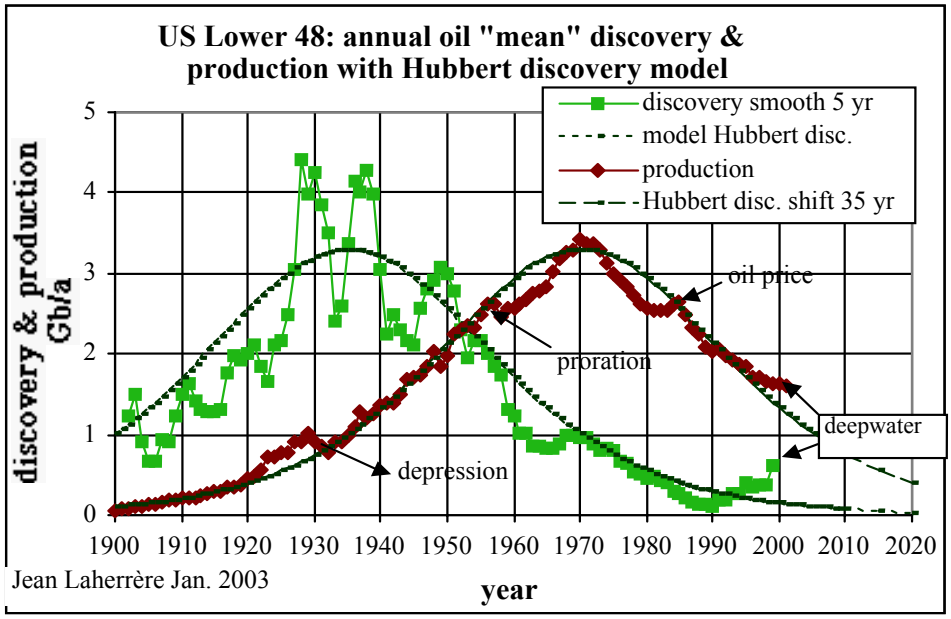

Figure 3: Annual discovery and production of oil in US lower 48 states. (Jean Laherrère, January 2003.)

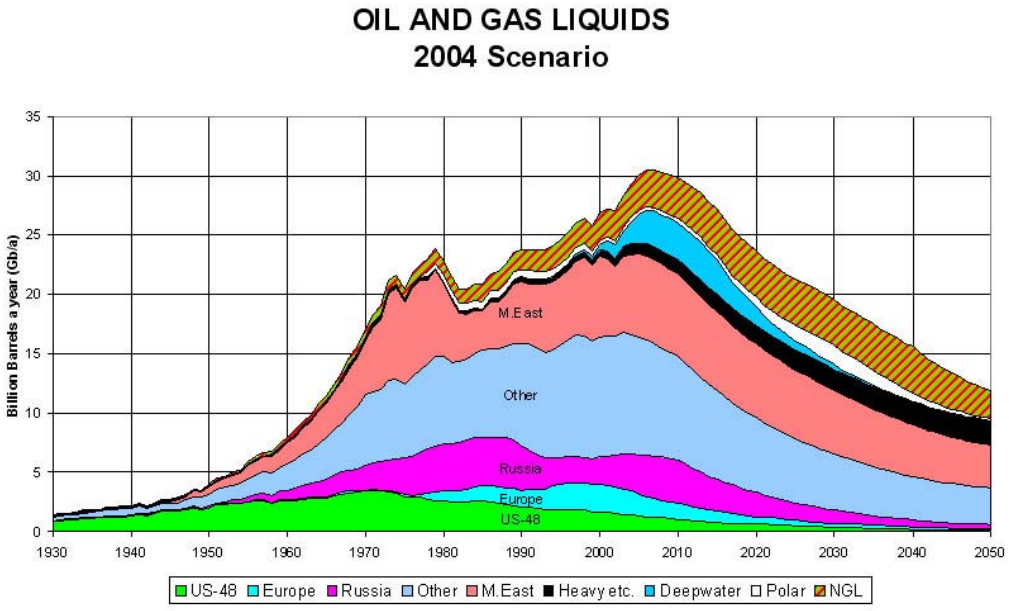

Figure 4: Oil and gas liquids scenario (updated from K. Aleklett and C.J. Campbell, Minerals & Energy, 2003; 18:5-20)

Statements on Oil

by the Energy Committee at

the Royal Swedish Academy of Sciences.

Introduction

The Royal Swedish Academy of Sciences is an independent non-governmental organization, with expertise in most of the sciences as well as economical, social and humanistic fields. The Academy has recently established a committee to consider today's important energy issues that need our full, unbiased attention. The Energy Committee has a national as well as a global perspective and will summarize scientific knowledge on the supply and use of energy as well as the predicted impacts on society over the coming 50 years. Sustainability and environmental considerations are essential for any future energy system. Readily available, inexpensive and environment-friendly energy provides the foundation for economic growth and prosperity.

The Energy Committee has selected a number of subjects to be studied in some depth. One of these deals with oil and related carbon-based fuels. Therefore, the Committee, organized, together with the Committee of Energy and Environment of the Royal Academy of Engineering Sciences, a seminar with the title "Running out of oil – scientific perspectives on fossil fuels" held at the Academy on 26 May 2005. Prior to the Seminar, the Energy Committee conducted a hearing with the seminar participants. More information about this seminar can be found on the Academy's web page www.kva.se. The Committee also arranged a hearing with speakers in an Uppsala seminar on "Global oil reserves" on 23 May 23 2005 together with the Graduate School of Instrumentation and Measurements (AIM). Members of the Committee participated in the Uppsala seminar. Some essential points brought up at the hearings and

seminars are highlighted below. It should be pointed out that the perspective given here is not purely scientific, since there are important social, political and technical factors that need consideration.

General remarks

It is very likely that the world is now entering a challenging period for energy supply, due to the limited resources and production problems now facing conventional (easily accessible) oil. Nearly 40 % of the world's energy is provided by oil, and over 50% of the latter is used in the transport sector. An increasing demand for oil from emerging economies, such as China and India, is likely to further accentuate the need for new solutions. In addition, it is important that the poorer countries have access to oil at reasonable prices to meet their development goals. This places an additional burden on responsible, matured economies. Compared to many developing countries, the same percentage increase in the crude oil price will be less problematic for Sweden and other European countries because of our tax system (the crude oil's share, c. 25%, in the gasoline price is quite small, compared to the taxes). The poor countries will suffer most from an increased price.

China and India and several nations in South-East Asia and Latin America are now experiencing rapid economic development. Continued high oil prices will jeopardize their chances of economic growth. Many countries, for example in Africa, may not even be able to develop economically in the absence of cheap oil. With China and India emerging as engines of the global economy, the sharp increase in the oil prices which we are witnessing today could lead to a serious international economic recession, similar to those that followed the oil price increases in 1973-74 and 1981. The European economies may be severely affected.

There is at present an extreme dependence on supply from the Middle East holding more than 60 % of the global oil reserves. A key country is Saudi Arabia, which is supposed to hold about 20% of the global reserves of conventional oil and much of the world's spare capacity. Some analysts maintain that there are inherent technical problems in the Saudi oilfields, but

this is not an uncontested viewpoint. It is uncertain how much the oil production in the Middle East can be increased in the next few years and to what extent it would be in the interest of these countries to greatly increase production. It is clear that, even in these countries, conventional oil is a limited resource that they are almost totally dependent on. It is, however, also clear that the countries of the Middle East are undergoing massive internal and regional changes which may have negative consequences for the global oil supply system. Mitigation measures must be initiated in the next few years in order to secure a continued adequate supply of liquid fuels, especially for the transport sector. Over the longer term, completely new solutions are required. Therefore, increased R&D (Research and Development) in the energy sector is urgently needed.

Key points

1. Shortage of oil

The global demand for oil is presently growing by nearly 2 % per year and the current consumption is 84 million barrels per day (1 barrel=159 liters) or 30 billion barrels per year. Finding additional supplies to increase the production rate is becoming problematical, since most major oilfields are well matured. Already 54 of the 65 most important oil-producing countries have declining production and the rate of discoveries of new reserves is less than a third of the present rate of consumption.

2. Reserves of conventional oil

In the last 10-15 years, two-thirds of the increases in reserves of conventional oil have been based on increased estimates of recovery from existing fields and only one-third on discovery of new fields. In this way, a balance has been achieved between growth in reserves and production. This can’t continue. 50% of the present oil production comes from giant fields and very few such fields have been found in recent years. Oil geologists have a wide range of opinions on how much conventional oil there is yet to be discovered, but new reservoirs are expected to

be mainly found in the deeper water, outer margins of the continental shelves, and in the physically hostile and sensitive environments of the Arctic, where the production costs will be much higher and lead times much longer than they are today. A conservative estimate of discovered oil reserves and undiscovered recoverable oil resources is about 1200 billion barrels, according to the US Geological Survey; this includes 300 billion barrels in the world's, as yet unexplored, sedimentary basins.

3. Middle East's key role

Only in the Middle East and possibly the countries of the former Soviet Union is there a potential to significantly increase production rates to compensate for decreasing rates in other countries. Saudi Arabia is a key country in this context, providing 9.5 million barrels per day (11% of the current global production rate). Their proven reserves are 130 billion barrels and their reserve base is said to include an additional 130 billion barrels. Iraq also has considerable untapped oil reserves.

4. Unconventional oil resources

In addition to conventional oil, there are very large hydrocarbon resources, so-called unconventional oil, including gas (c. 1000 billion barrels of oil equivalent, much of which could be converted to liquid fuels), heavy oil and tar sands (c. 800 billion barrels) and oil shales (c. 2 700 billion barrels); coal, from which liquid fuels can be produced and methane hydrates provide a vast additional potential. During a transition period, gas often available adjacent to the oil fields, will help to bridge future deficits of conventional oil. With the exception of gas, all unconventional oil is expensive to produce (c. $ 20-40/barrel) and exploitation involves significant environmental problems. At $ 40 oil, which is now commonly accepted as the long term equilibrium price, the cost of developing unconventional oil is less problematic. (see pt. 7 below). At present, 1 million barrels of oil per day comes from Canadian tar sand and 0.6 million barrels from Venezuelan heavy oil. The Canadian government estimates that by 2025 the daily production rate will have increased to 3 million barrels per day. Thus, the problem

with these unconventional oils is not so much price, but lead times and non-price related aspects, such as the effects on the environment and availability of water and natural gas for the production process.

5. Immediate action on supplies

Forceful measures to improve the search for and recovery of conventional oil as well as improving the production rate of unconventional oil are required to avoid price spikes, leading to instability of the world economy in the next few decades. Improved recovery of oil in existing fields can be expected. The estimated reserves of conventional oil are, however, located primarily in unexplored sedimentary basins, in environments difficult to access. A substantial part has yet to be found! Sizeable contributions from unconventional oil need time (some decades) to become really effective. It is necessary to have public funding for long term petroleum-related research, since this must not be an exclusive task for the oil companies.

6. Liquid fuels and a new transport system

Oil supply is a severe liquid fuels problem and less of a general energy supply problem; 57 % of the world's oil is consumed in the transport sector. Unless government's ration oil, there will never be a shortage of oil; just increasing prices. Major programs need, therefore, to be implemented to develop alternatives to oil in the transport sector. Until these measures have been introduced, (which may take one to two decades) demand for oil for the needs of a globally expanding transport sector will continue to rise; other users of oil will suffer, including those concerned with power generation.

7. Economic considerations

At present the high oil prices are due to the limitations of worldwide production, refining and transportation capacities. Furthermore, the price is influenced by the threat of terrorist attacks on the world's oil supply, transport system and infrastructure. In the long run, the price of crude oil will be determined by the price of substitutes. Some estimates indicate that oil may

be produced from tar sand at a price of 20-25 USD a barrel, compared to the present cost of about USD 5 for Saudi Arabian oil. Liquid fuels from coal could be produced for many decades; cost estimates vary greatly and generally exceed USD 30. Factors that are hard to estimate are environmental requirements, taxation levels and profit margins. However, we can anticipate continued high oil prices, as long as the pressure from the expanding Asian economics is maintained.

8. Environmental concerns

Unconventional oil will significantly extend the length of the hydrocarbon era, assuming that the negative impacts on the environment can be avoided. Constraints similar to those imposed on other fossil fuels (for example emission controls and CO_2 sequestration) will be necessary and provide major challenges for industry. The impact on the environment, in general, and on the atmosphere and climate in particular, produced by combustion of fossil fuels, is not considered here. However, it is worth noting that such considerations provide further support for the conclusions presented below.

9. Increased R&D and international efforts

To avoid acute economical, social and environmental problems worldwide, we need a global approach, with the widest possible international cooperation. Activities in this direction have started and they should be strongly encouraged and intensified; the technically advanced countries have a particular responsibility. Considerably increased resources for R & D on alternative non-fossil energy sources, as well as on efficient and sustainable use of energy, particularly electricity, are necessary. In order to develop a sustainable energy system beyond the fossil fuel era, we need a full system analysis of the energy sector based on realistic time scales. The Energy Committee intends, in the next couple of years, to study other sources of energy and evaluate their relative merits and impact on environment and climate.

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